भारतीय मानक

Indian Standard

IS 18381 (Part 1) : 2023

मानव रहित हवाई वाहन (यूएवी) — सामान्य अपेक्षाएँ

भाग 1 सैन्य अनुप्रयोगों के अलावा

Unmanned Aerial Vehicles (UAV) — General Requirements

Part 1 Applications Other Than Military Purposes

ICS 49.020

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Unmanned Aerial Vehicles Sectional Committee, TED 32

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Unmanned Aerial Vehicles Sectional Committee had been approved by the Transport Engineering Division Council.

It is the responsibility of the owners, users or manufacturers who intend to design, build or maintain a UAS for Indian context to comply with requirements of this standard. The intent is to lay a foundation of requirements which enables the manufacturer to produce safe and reliable UASs in the interest of all stakeholders.

This standard is being published in two parts. The first part in this series is applicable for design of UAS other than military application (with or without armament, explosives, weapons, EM emitters etc). The other part in this series is under consideration by the committee for military applications.

The design of an UAS is done with a specific operational context and mission in mind, the materials are chosen accordingly and the maintenance procedure is thus designed as per reliability computations.

The manufacturer is advised to understand the scope of standard, the mission requirements, and the context of operation when designing a UAS. The certification process can be overwhelming, especially for manufacturers intending to perform BVLoS operations. The requirements are stringent due to required safety, reliability and security measures and UASs shall also comply with prevailing rules and regulations in the country as notified by the government.

UAS operations impose several risks. It is evident that safety and security of involved people, organizations and the environment are of prime importance and pure business objectives shall not take precedence. A good knowledge of disciplines involved, engineering maturity and a sense of responsibility is expected from the manufacturer to create safe and reliable products.

Considerable assistance has been derived from following references:

a) Equipment, systems, and installations, SC-RPAS.1309-03;
b) DO-178C — Software Considerations in Airborne Systems and Equipment Certification; and
c) DO-254 — Design Assurance Guidance for Airborne Electronic Hardware.

The manufacturer is also advised to follow IS/ISO 9001 : 2015 for process and quality compliance.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

Indian Standard

UNMANNED AERIAL VEHICLES (UAV) — GENERAL REQUIREMENTS

PART 1 APPLICATIONS OTHER THAN MILITARY PURPOSES

1 SCOPE

This standard applies to all the constituent elements of a unmanned aerial vehicle (UAV) or unmanned aircraft systems (UAS); for design, fabrication and maintenance of all the categories of UASs such as nano – up to 250 g, micro – 250 g to 2 kg, small – 2 kg to 25 kg, medium – 25 kg to 150 kg and large – greater than 150 kg MTOW (maximum take-off weight).

2 REFERENCES

The standard given below contains provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard given below:

IS No.	*Title*
IS 16046 (Part 2) : 2018	Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for portable sealed secondary cells and for batteries made from them for use in portable applications: Part 2 Lithium systems (*second revision*)

3 UAS CONFIGURATION

Airframe is the main body of a UAS. It is typically where all the components of a UAS are housed. The classification of UAS is given in Table 1.

4 POWER SOURCES

According to the type of use, the power sources for any UAS, the classification is given in Table 2.

Table 1 UAS Types

(*Clause* 3)

Sl No. (1)	**UAS Type** (2)	**Classification** (3)
i)	Multi-copter (tri, quad, hexa, octa, etc), including tethered UASs	MC
ii)	Fixed wing	FW
iii)	Tilt wing	TW
iv)	Helicopters	HE
v)	Gyrocopter	GC
vi)	Fixed wing multi-copter hybrid (VTOL) including tilt rotor	VT
vii)	Others	OT

Table 2 Power Sources

(*Clause* 4)

Sl No. (1)	**Power Source** (2)	**Classification** (3)
i)	Battery	B
ii)	Fuel cell	F
iii)	Internal combustion engine (ICE)	I
iv)	Turbine	T
v)	Internal combustion engine (ICE) – Battery hybrid	IBH
vi)	Turbine-battery hybrid	TBH
vii)	Internal combustion engine (ICE) – Fuel cell hybrid	IFH
viii)	Turbine-fuel cell hybrid	TFH
ix)	All	A
x)	Any other	X

5 DESIGN REQUIREMENTS

5.1 General

5.1.1 The manufacturer shall define the operational context of the UAS.

5.1.2 The manufacturer shall take into account the operational environment constraints of the UAS. This could be due to the zone in which it operates such as railway infrastructure, electrical wires, prohibited flying zones, the weather/climate and any other imposed or implied constraints.

5.1.3 The manufacturer shall perform a hazard analysis and take the results into account to improve the system design.

5.1.4 The result and actions identified by hazard analysis shall be used to eliminate risk by including safety features in the design and operational procedures.

5.1.5 The overall design shall demonstrate and provide confidence in its operational capability.

5.1.6 The manufacturer shall ensure the quality of material selected and used for manufacturing of parts meets the design criteria.

5.1.7 The manufacturer shall demonstrate that the size of the UAS has been derived mathematically by considering mission requirements (for example, required endurance, sensors/payload tocarry, range).

5.1.8 The manufacturer shall compute the payload capacity of the UAS.

5.1.9 The manufacturer shall determine the MTOM (maximum take-off mass) for the UAS.

5.1.10 A factor of safety (preferably 1.5) for computing ultimate loads shall be used. (ultimate load = 1.5 × limit load).

5.1.11 The manufacturer shall determine the CG of the UAS, changes due to variation in payload, fuel usage, and movement of articulated mechanism if any and associated operating limitations.

5.1.12 The design conditions of the UAS at the time of determining its mass and center of gravity shall be well defined and easily repeatable.

5.1.13 The structural design shall be such that it is immune to the vibrations caused by the rotors/ fans/propellers over all the speed ranges of the UAS operation.

5.1.14 The structural design shall account for loads and changes caused by additional accessories and systems (for example, camera gimbal, spray system etc), their malfunctions, failures on the UAS performance.

5.1.15 The loads resulting from a likely failure of a system, component, engine, rotor or propeller shall be determined.

5.1.16 The manufacturer shall establish critical flight loads for symmetrical and asymmetrical loading at all speeds and load factors at and within the boundaries of the maneuver and gust envelope.

5.1.17 Pressurized compartments shall be designed to sustain pressurization and depressurization fatigue cycles.

5.1.18 Pressurized compartments shall withstand the pressure differential loads corresponding to the maximum relief valve setting multiplied by a factor of 1.33.

5.1.19 The UAS structure shall be designed to withstand pressure differential loads from zero to a maximum setting of the relief valve.

5.1.20 When a hydraulic system is used, the manufacturer shall assure that they are designed for all loading conditions in flight.

5.1.21 When a hydraulic system is used, its fluid shall be an approved for aviation usage.

5.1.22 When a hydraulic system is used, it shall be leak proof.

5.1.23 The system containing high energy rotating parts shall be designed to contain failure, fragments within itself without damaging any other structure or component to ensure a continued safe flight.

5.1.24 The mechanical design shall be such that it is impossible to assemble the product incorrectly.

5.1.25 Tethered UAS manufacturer shall perform the aerodynamic, mechanical load on the UAS created by winds to demonstrate structural integrity of tether and UAS.

5.2 Failure Condition Classification

The classification of different failure conditions is given below and corresponding failure probability is given in Table 3.

5.2.1 *Catastrophic* — A failure condition which results in loss of life, fatality, damage to RPA (remotely piloted aircraft), loss of RPA, property.

5.2.2 *Hazardous* — A failure condition which would result in heavy work load for remote pilot, struggle to control the RPA and no possibility of fatality, no damage to RPA or property.

5.2.3 *Major* — A failure leading to reduction of safety margin, reduced efficiency of pilot, respecting airspace rules, capability reduction.

5.2.4 *Minor* — A failure not impacting safety, may lead to change of flight plan, increase in workload of remote pilot.

5.2.5 *No Effect* — A failure that has no impact on safety of RPA operational capability.

6 FLIGHT ENVELOPE

6.1 The manufacturer shall determine the flight envelope of the UAS.

6.2 The manufacturer shall determine the flight loads resulting from a likely failure of a UAS system, component, engine, rotor or propeller.

6.3 The manufacturer shall establish critical flight loads for symmetrical and asymmetrical loading from all combinations of flight loads at speeds and load factors at and within the boundaries of the maneuver and gust envelope.

6.4 The manufacturer shall demonstrate that vibration, including air resonance, and buffeting does not result in structural damage up to the maximum design speed.

6.5 The manufacturer shall determine the structural design loads resulting from taxi, take-off, launch, landing, handling, and transportation conditions on the applicable surfaces in normal and adverse attitudes, configurations, and conditions.

6.6 The designed flight envelope shall demonstrate the inclusion of safety margins as specified by the standard.

6.7 A means shall be provided to prevent exceeding the approved flight envelope.

Table 3 Failure Condition Mapping

(*Clause* 5.2)

Sl No. (1)	Design Assurance Level (DAL) (2)	Failure Probability (Per Flight Hour) (3)
i)	Catastrophic (A)	$< 10^{-8}$
ii)	Hazardous (B)	$< 10^{-6}$
iii)	Major (C)	$< 10^{-4}$
iv)	Minor (D)	$< 10^{-3}$
v)	No effect (E)	No requirement

7 CONTROL AND STABILITY

The UAS shall be controllable and maneuverable, within the designed flight envelope. This shall be demonstrated:

a) During all phases of flight, including ground phases where applicable;
b) At all loading conditions for which certification is requested;
c) During configuration changes where applicable;
d) With likely propulsion system failure;
e) With reversible flight control if likely to occur;
f) In all degraded operating modes of the flight control system(s); and
g) Considering all effects of sensors, and computational errors and delay.

8 PERFORMANCE

8.1 The maximum range travelled in still air shall be determined at MTOM.

8.2 The maximum endurance capability shall be determined in still air at MTOM.

8.3 The maximum operational altitude shall be determined at MTOM.

8.4 The ceiling height shall be determined at MTOM.

8.5 The manufacturer shall determine the minimum safe steady flight speed for each flight configuration and phases of flight for the UAS.

8.6 The minimum safe speed determination shall take into account the most adverse conditions for each flight configuration within the designed flight envelope.

8.7 Where applicable, the stall speed of the UAS shall be determined.

8.8 The manufacturer shall generate performance data in view of the flight envelope, accounting for varying atmospheric conditions, cooling needs, and other demands on power sources.

8.9 The manufacturer shall determine the most critical flight phase for the UAS and generate minimum performance data for that phase.

8.10 The minimum performance operating limitations shall be shared with the operator along with the operating procedure in the user or flight manual.

8.11 The manufacturer shall demonstrate the minimum performance within operating limitations as per the user or flight manual.

9 PROPULSION

9.1 General

9.1.1 The manufacturer shall compute the power, thrust and energy requirements for the mission profile.

9.1.2 The manufacturer shall select the power/ thrust device to meet mission requirements with adequate safety margins.

9.1.3 Functions/systems that affect available power shall be taken into account for sizing the propulsion system.

9.1.4 The power source shall meet the mission requirements with reserves for at least 10 minutes of flight time.

9.1.5 For vertical take-off and landing (VTOL) designs, thrust to MTOM ratio greater than 1.5 shall be used.

9.1.6 The manufacturer shall determine the total thrust generated by the rotor(s), propeller(s), a turbine engine used for propulsion to demonstrate the thrust to weight ratio.

9.1.7 The electronic speed controller shall be selected by considering a safety factor greater than 1.5 above the peak current consumption of the motor.

9.1.8 The propeller speed and pitch of the propeller shall be computed for safe operation under all conditions.

9.1.9 Propulsion system startup and shutdown procedure shall be clearly documented and supplied to the operator.

9.1.10 Propulsion system operation conditions and operating limits shall be clearly documented and supplied to the operator.

9.1.11 Emergency recovery procedure for propulsion system shall be clearly documented and supplied to the operator.

9.1.12 It shall be possible to shut down an engine or restart a stopped engine to ensure a safe sustained flight in case of undesired event.

9.1.13 All critical parameters for safe operation of propulsion system shall be available to the operator on the ground.

9.1.14 A UAS intended to be flown in heavy rain, snow, ice conditions shall:

a) Prevent accumulation of water, snow, ice in the engine; and

b) Demonstrate sustained power plant operations due to ingested water, snow and ice under such conditions.

9.1.15 A UAS not designed to fly in rain, snow, ice conditions shall:

a) Offer protection of the propulsion system by avoiding exposure to such conditions; and

b) Define operating limitations to prevent any inadvertent entry into rain, snow, ice conditions during the flight.

9.1.16 Where applicable, the transformed high energy gases shall leave the propulsion system unobstructed without adversely affecting the structure and/or any other subsystem on board.

9.1.17 For all the power sources, the manufacturer shall demonstrate the UAS for steady output and fail safe/protection mechanism shall be available in case of abrupt output.

9.2 IC Engine

9.2.1 A UAS using IC engine(s), turbine engine(s) shall ensure that appropriate cooling measures are part of design and exhaust gases are removed so as not to create hazard for other components and structure.

9.2.2 The IC engine performance parameters shall be monitored to sustain optimal and safe operation over different flight phases and alert pilot about abnormal operation.

9.3 Turbine Engine

9.3.1 A UAS using turbine engine(s) shall ensure that appropriate cooling measures are part of design and exhaust gases are removed so as not to create hazard for other components and structure.

9.3.2 The turbine engine performance parameters shall be monitored to sustain optimal and safe operation over different flight phases and alert pilot about abnormal operation.

9.4 Fuel Cell System

9.4.1 A UAS using turbine engine(s) shall ensure that appropriate cooling measures are part of design and exhaust gases are removed so as not to create hazard for other components and structure.

9.4.2 The fuel cell system shall monitor its performance parameters to sustain optimal and safe operation over different flight phases to alert pilot about abnormal operation.

9.5 Battery Systems

The battery system shall comply with requirements of IS 16046 (Part 1).

9.6 Energy Storage

9.6.1 The energy source could be liquid, gaseous fuel or a rechargeable battery.

9.6.2 Energy source shall be placed in such a way as to minimize the heat exposure to electronic and structural elements.

9.6.3 Energy source shall be placement and designed to prevent any hazardous event (fuel leak, fire, explosion risk).

9.6.4 Energy storage system shall be designed to store energy required for the mission profile with required safety margins.

9.6.5 Energy storage system shall be designed to be redundant and independent to avoid single event linked failure.

9.6.6 Ignition source shall be placed as far as possible from the energy storage.

9.6.7 It shall be possible to isolate a faulty energy storage system.

9.6.8 Energy storage system shall ensure uninterrupted supply of energy to all required systems under all conditions except if an equipment fails and it requires isolation.

9.6.9 Energy distribution system shall sustain varying energy demands or fluctuations due to system needs.

9.6.10 Energy storage system shall be designed to sustain lighting strikes when lightening exposure is likely and certification is requested.

9.6.11 Energy storage shall be designed and manufactured to avoid occurrence of hazardous event during refill/recharge.

9.6.12 Energy storage system shall be designed to prevent contamination during storage and supply of energy.

9.6.13 Energy storage system shall be capable of jettisoning energy safely if this function is provided.

10 FUNCTIONS AND SYSTEMS

10.1 General

10.1.1 The sensor(s) shall be chosen such that they meet or exceed the minimum mission requirements and as laid down for the data provided by sensors in flight data recorder (FDR) requirements.

10.1.2 The system design shall be such that the DAL requirement is satisfied.

10.1.3 All critical flight data required for safe operation of the UAS shall be communicated over a secure data link to the operator.

10.1.4 All critical flight data required to monitor system operational state and performance shall be communicated over a secure data link to the operator.

10.1.5 Operational limitations of the systems shall be clearly specified in the operator flight manual.

11 CYBERSECURITY, DATA, COMMAND AND CONTROL

11.1 Radio link used for communication, the data exchanged thereof shall be determined and stated.

11.2 Cybersecurity, threat and risk analysis shall be performed for UAS systems and network.

11.3 All cybersecurity risks identified shall be mitigated as part of design.

11.4 UAS systems and network shall be protected from unauthorized access.

11.5 Radio link shall use AES 256 encryption or better.

11.6 Radio link used for communication shall be jam and spoof proof.

11.7 Radio link used for communication shall comply with EMI/EMC criteria.

12 ALTITUDE SYSTEM

12.1 The UAS shall have barometric system with capability for sub-scale calibration and setting.

12.2 Barometric altitude measurement shall be compensated for change in air density.

12.3 A UAS intending to fly long distances and integrating to commercial airspace ATM shall be installed with a precision altimeter.

12.4 The altitude shall be reported in feet.

12.5 Rate of change of altitude shall be reported in feet per minute.

13 SPEED SYSTEM

13.1 A UAS shall be equipped with reliable and redundant speed measurement devices.

13.2 The speed shall be measured and reported in knots.

14 ANGLE OF ATTACK SYSTEM

14.1 A fixed wing UAS shall be equipped with an angle of attack measurement system.

14.2 Angle of attack shall be reported in degrees.

15 NAVIGATION SYSTEMS

15.1 The UAS shall be equipped with a compass to inform the operator of its heading.

15.2 The compass system shall take into account local magnetic variation to correct directional information.

15.3 The heading shall be reported in degrees.

15.4 The UAS shall be equipped with reliable and redundant position determination systems such as navigation with Indian constellation (NavIC).

15.5 The position accuracy shall be better than 5 m.

15.6 A UAS expecting to be integrated in commercial airspace and infrastructure shall be equipped with very high frequency omni-directional range (VOR), distance measuring equipment (DME), instrument landing system (ILS), and microwave landing system (MLS) as per regulatory requirements.

16 FLIGHT CONTROL SYSTEM

16.1 The flight control system shall be designed taking into account the mission requirements, flight phases, navigation sources, UTM interfaces, integrated sensor characteristics, collision avoidance, operating infrastructure and other systems intended to be operated.

16.2 The flight control system behavior shall be predictable and follow pilot input for manual flight.

16.3 A fixed wing UAV FCS shall be designed such that the UAS never enters a stall condition.

16.4 The flight control system shall keep the UAS within the designed and defined flight envelope.

16.5 The flight control system shall impose limits for pitch, roll and yaw axes as per UAS design parameters to avoid performing aerobatic maneuver.

16.6 The flight control system shall keep the UAS on the pre-defined flight path except in case of collision avoidance maneuver, after which it should return back to the pre-defined flight path.

17 GEO-FENCING

17.1 The UAS may have Geo-fencing capability to avoid entering restricted airspaces and perform operations in predefined approved area.

17.2 Based on trajectory parameters, the geo-fencing function shall generate alerts for the pilot to prevent violation.

17.3 In case the UAS is approaching the geo-fence, an alert shall be given by the UAS to the user.

17.4 In the event of geo-fence violation, the UAS shall generate an alert to the pilot for taking corrective action in less than 5 s.

18 LIGHTS

18.1 The UAS intended for night operations shall be equipped with flashing anti-collision strobe lights:

a) Aviation green on the right extreme edge;
b) Aviation red on the left extreme edge; and
c) Aviation white on the longitudinal center line, aft of the UAS.

18.2 The green and red lights shall be placed as far apart laterally as possible on the UAS.

18.3 The white light shall be placed as far as possible, towards aft, on the UAS.

18.4 Taxi and landing lights when required shall be installed to provide clear visibility and guidance to the operator for intended operations.

18.5 UASs intending to use commercial airspace shall comply with civil aviation requirements (CAR) for color, field of coverage, light intensity, flash rate.

19 ENVIRONMENT SENSING AND COLLISION AVOIDANCE

19.1 An aircraft environment surveillance system (AESS) shall be designed to provide the UAS and the operator situational awareness supporting obstacle detection and avoidance decisions including detection of other UASs, flying objects, and respect minimum air separation conditions. The collision avoidance trajectory shall be generated to respect the minimum air separation requirements.

19.2 The AESS intended for collision avoidance shall be able to generate advisory alerts for the pilot and provide distance, size and direction of movement information on detected objects to the operator.

19.3 The UAS shall use the other UAS trajectory information to perform dynamic collision avoidance.

19.4 When the UAS performs a collision avoidance maneuver, the UTM system shall be informed automatically about the incident.

19.5 A collision avoidance system independent of UTM shall be available for safe fallback in case UTM systems or network failure.

19.6 The AESS sensors/system selection process shall take into account the UAS performance parameters to compute sufficient time for safety maneuver.

19.7 The AESS vision sensors/system selection process shall take into account the atmospheric, weather conditions in which the UAS is designed to operate.

20 ENERGY MEASUREMENT

20.1 The UAS shall compute the energy remaining onboard and communicate to the operator.

20.2 The UAS shall alert the operator about abnormal energy consumption or loss.

21 LIGHTNING PROTECTION

21.1 A UAS intended for flying in all weather conditions and susceptible to lightning exposure shall utilize lightning protection system.

21.2 The UAS shall be designed to avoid any failure and demonstrate sustained flight despite lightning exposure.

21.3 Operating limits shall be clearly specified by the manufacturer when the UAS is not certified for managing lightning exposure.

22 ELECTRICAL POWER

22.1 Power distribution system shall ensure uninterrupted supply of power to all required systems under all conditions except if an equipment fails and it requires isolation.

22.2 Power distribution shall ensure each connected system receives power as per its rating and variation tolerance limits.

22.3 It shall be possible to isolate a faulty energy distribution system/path.

22.4 Power distribution system shall sustain varying energy demands or fluctuations due to system needs.

22.5 Electrical wires/cables shall take into account the peak voltage and current transmitted over electrical cable, its characteristics to size the power conductor for the application, including a safety factor of 1.2.

22.6 The electrical wires carrying strong currents, susceptible to heating shall be monitored for temperature.

22.7 Power distribution systems shall be designed to sustain lightning strikes if lightning exposureis likely as part of mission.

22.8 Electrical wires shall be fire-resistant.

22.9 The routing of electrical wires shall be done to eliminate interference with electronic signals.

22.10 Electronic signal shall be transmitted over twisted shielded wires to avoid electromagnetic interference.

23 DOORS AND HATCHES

23.1 Doors, access hatches and canopies shall be protected against inadvertent opening in flight.

23.2 Doors, access hatches and canopies shall be monitored for their closed/open state to generate alert for the pilot.

23.3 Doors and hatches designed to be opened during flight shall be shown to create no hazard, when opened in flight.

24 FLIGHT DATA RECORDING

24.1 The UAS shall have the capability to record the flight data.

24.2 The flight data recorder shall maintain a record of at least 2 flights, the current and the previous.

24.3 The recorded values shall meet the designated range, resolution and accuracy requirements during static and dynamic conditions.

24.4 The flight data parameters shall be encoded and recorded in unicode character set.

24.5 The manufacturer shall make available the flight data recorder data for incident investigation.

24.6 The manufacturer shall make available the flight data decoder for incident investigation.

25 MOVABLE PAYLOAD (GIMBAL, VIDEO SYSTEMS, ETC)

25.1 Where a video system is used on the UAS, it shall be demonstrated not to have any adverse effect on the stability and control when the camera orientation is changed.

25.2 Where a moving payload system like gimbal, video system etc is used on the UAS, it shall not affect the stability and control under all circumstances.

26 SMOKE AND FIRE SAFETY

26.1 A smoke detection system shall be installed onboard to provide an alert to the pilot for taking action for avoiding any damage and land the UAS in a safe zone.

26.2 A fire detection system shall be installed onboard to provide an alert to the pilot for taking action for avoiding any damage and land the UAS in a safe zone.

27 SOFTWARE AND HARDWARE BASED RECONFIGURATION

27.1 Where a UAS’ configuration is modifiable through software setting, the manufacturer shall ensure by design that an invalid setting, combination cannot be used for operations.

27.2 Where a UAS’ configuration is modifiable through hardware setting, the manufacturer shall ensure by design that an invalid setting, combination cannot be used for operations.

28 ONBOARD DIAGNOSTICS

28.1 Where onboard built-in test, diagnostics are implemented, the manufacturer shall ensure the results availability to the operator in comprehensible language.

28.2 Where onboard built-in test, diagnostics are implemented, the manufacturer shall ensure that RPA cannot be flown when safety impact is observed.

28.3 The manufacturer shall ensure that onboard built-in test, diagnostics results are securely stored and available for incident investigation.

28.4 Onboard built-in test, diagnostics results shall aid the defect resolution and maintenance activity.

29 SAFETY REQUIREMENTS

29.1 General

29.1.1 The UAS shall have a safety mechanism onboard to bring it down automatically and safelyif it loses radio contact. The following safety mechanism shall be followed:

a) If the navigation systems are still operation fly back to operation base; and
b) Identify a safe landing spot and land itself.

29.1.2 The UAS shall find and land in a safe location if a smoke/fire event is detected.

29.1.3 The UAS manufacturer shall ensure the following by design for a forced landing, controlled crash or autonomous flight termination into a designated area as an emergency recovery, the procedure should be designed as far as practical so that:

a) Any explosion after the forced landing shall not constitute a hazard for people outside the designated area;

b) Projection of parts (items of mass to be considered include, but are not limited to engines and payloads), which may constitute a potential injury to people, outside the designated area, is unlikely; and

c) The UAS does not constitute a source of ignition or leak of flammable fluids in hazardous quantities.

29.1.4 The UAS shall have autonomous flight termination system or return to home (RH) option in case of safe flight capability degradation or safety incident.

29.1.5 The UAS manufacturer shall ensure that systems are operated in safe temperature range as specified by the manufacturer.

29.1.6 It shall be possible to over-ride any automatic function to continue safe flight at any point of time.

29.1.7 The automatic system shall not interfere with manual operations once the over-ride has been selected.

29.1.8 The UAS shall find and land in a safe location in case of sudden power loss and inability to recover.

29.2 Electronics Installation

29.2.1 All the electronics shall be installed in a way to avoid exposure to fire and high-temperature areas.

29.2.2 All the electronics shall be installed in a way to limit interference from and to sources of electromagnetic interference.

29.3 Cargo Transportation

29.3.1 The manufacturer shall design cargo compartments to properly secure the cargo to prevent shifting and creating a hazard.

29.3.2 The compartment shall be able to support the loads induced by the cargo.

29.3.3 The cargo compartment shall avoid carrying any control and electrical lines to ensure safe flight and power controls.

29.3.4 A UAS designed to carry cargo shall ensure that suspension and securing mechanism is designed to carry targeted payload including safety margins as specified in mechanical design section.

29.3.5 A UAS designed to carry external cargo shall ensure that suspended cargo does not create a hazardous flight situation or to the people on ground.

29.3.6 The manufacturer of a UAS designed to carry external cargo shall determine the maximum angle of roll and pitch during operation of UAS for safe flight control.

29.3.7 The manufacturer shall clearly indicate in the user manual, the capacity and performance limits of UAS with the payload.

29.4 Logistics, Storage, Reconfiguration

29.4.1 Where a UAS or part of the system is designed to be transportable, assembled, disassembled, or reconfigured for transportation, the following shall apply:

a) The mechanical design shall be such that it is impossible to assemble/reconfigure the product incorrectly;

b) The conditions defined for the storage and transportation shall not adversely affect the air worthiness of the UAS;

c) A reconfigurable design shall ensure that a bad reconfiguration is not possible for mechanical design; and

d) A reconfigurable design shall ensure that a bad reconfiguration generates an error in case of software and electronic reconfiguration and flight is not possible.

29.5 Launch and Recovery Systems

29.5.1 Launch and recovery system shall comply with the design requirements stated in the standard.

29.5.2 Launch and recovery system shall not create a hazardous operating environment or situation during the operation.

29.6 Design Reliability Analysis

29.6.1 Any single failure or likely combination of failures of a power, thrust control, flight control system shall not prevent continued safe flight and landing of the UAS or the emergency recovery procedure.

29.6.2 Maximum shelf life of the individual components shall be determined.

29.6.3 Maximum shelf life of the product shall be determined.

29.6.4 The manufacturer shall perform an aero-elasticity and fatigue analysis.

29.6.5 The manufacturer shall perform FMECA (failure mode, effects and criticality analysis) and FMEDA (failure modes effects and diagnostic analysis).

29.6.6 The manufacturer shall determine the MTBF (mean time between failures) of electrical, electronics, mechanical, batteries and constituent elements necessary for safe operation of the UAS.

30 MANUFACTURING AND ASSEMBLY REQUIREMENTS

30.1 Materials

30.1.1 The manufacturer shall provide evidence that selected material meets the required design assurance criteria.

30.1.2 The housing for electronics components shall be of fire-resistant material.

30.1.3 The structure shall be made of materials which can resist deterioration or loss of strength in operation due to any cause that is, weathering, corrosion and abrasion for the specified life of the UAS.

30.2 Process

30.2.1 All parts shall be clearly identifiable by numbering according to product configuration management system of the manufacturer.

30.2.2 All parts shall be clearly identifiable with marking according to product configuration management system of the manufacturer.

30.2.3 Energy storage shall be installed to avoid occurrence of hazardous event during refill/ recharge.

30.2.4 Energy storage shall be clearly labeled for the type to be recharged/refilled.

30.2.5 Energy storage shall be clearly labeled for its maximum capacity.

30.2.6 The manufacturing process shall ensure that electrical joints are secure and safe to avoid any hazardous event.

30.2.7 Electronics soldering shall be ensured to make proper contacts and sustain vibrations induced during operations.

30.2.8 Electrical wires shall be routed such that directional change maintains conducting and safety characteristics of the cable.

30.3 Flight Manual

30.3.1 The manufacturer shall produce and supply all necessary and advisory information to the operator for safe operations in the flight manual.

30.3.2 The flight manual shall:

a) Show the UAS, identify all parts with which user can interact, unambiguously state their purpose; and
b) Show the relation to the RPS, identify all parts with which user can interact, unambiguously state their purpose.

30.3.3 The flight manual shall describe procedures for launch and recovery systems or equipment.

30.3.4 The flight manual shall describe procedures for managing system malfunction during flight and recovery.

30.3.5 The manufacturer shall produce and supply emergency procedures to the operator in the flight manual.

30.3.6 The manufacturer shall produce and supply operational limitations of the UAS to the operator in the flight manual.

30.3.7 When a launch and recovery system is used, the manufacturer shall specify the safe zone requirements for operations.

30.3.8 The manufacturer shall produce and supply UAS maintenance procedure to the operator in the maintenance manual.

30.3.9 Clear, unambiguous illustrations and instructions for disassembling/assembling, reconfiguration, storage, the respective handling guidelines, and transportation shall be documented in the appropriate manual and supplied to the operator.

31 MAINTENANCE

31.1 Where the operator can perform maintenance of UAS, a maintenance manual shall be provided.

31.2 Maintenance procedure shall be specified in the operator maintenance manual with unambiguous instructions.

31.3 Maintenance procedure specified in the operator maintenance manual shall be supported by unambiguous and clear illustrations.

31.4 Replacement parts required to perform maintenance on the UAS shall be clearly identified and listed.

31.5 The manufacturer shall identify hazardous operations during maintenance procedure and specify them clearly in the maintenance manual.

32 GROUND HANDLING/SUPPORT SYSTEMS

32.1 The ground support systems required for UAS shall be designed according to the onboardsystem handling, installation location and support requirements.

32.2 The ground support systems required for UAS shall be designed to prevent any hazardous event to the operator or the UAS.

32.3 Energy storage system ground handling shall be designed to avoid occurrence of hazardous event.

32.4 The manufacturer shall take into account the human factors and limits for the design of ground support systems.

33 REMOTE PILOT STATION (RPS)

33.1 The UAS manufacturer shall determine and specify the number of operators needed to safely fly the UAS within regulatory constraints, in the flight manual.

33.2 The manufacturer shall specify the physical parameters of the required infrastructure to create a ground control station, in the flight manual.

33.3 The manufacturer shall define the infrastructure requirements (network, security, safety, power, backup power, heating, cooling, ventilation, temperature, humidity, noise suppression requirements etc) to create an RPS, in the flight manual.

33.4 The manufacturer shall define the operating environment conditions for a movable/open air/handheld RPS.

33.5 The manufacturer shall determine the human factors and limits for both movable and immovable RPS and communicate in the flight manual.

33.6 The RPS elements shall be designed to allow the operator accomplish its tasks efficiently.

33.7 The RPS elements shall be designed taking into account human physiology.

33.8 The RPS elements shall be color coded and labeled to allow the operator to identify and interpret them quickly.

33.9 The ambient lighting in an indoor RPS shall be designed to provide clear readability of information on indications, display devices, markings.

33.10 The interior or an indoor RPS shall be designed to avoid direct and indirect reflection of light to operator’s eyes.

33.11 The RPS display(s) shall be readable under all ambient light conditions without causing fatigue.

33.12 The RPS display(s) shall be selected to avoid reflection of projected shadows to maintain readability under all ambient light conditions.

33.13 RPS shall be under strict access control.

33.14 The information shall be presented in a clear, unambiguous way to the operator.

33.15 The information shall be organized according to criticality, usage frequency, and duration of associated task.

33.16 The choice of labels shall indicate the function, method of operation of controls, except when it is obvious.

33.17 The RPS shall allow the operator to perform tasks without fatigue and unreasonable concentration.

33.18 RPS controls shall be designed to allow operator to intervene in a manner appropriate to a task in normal and emergency situation.

34 MARKING

The UAS should have following labeled information:

a) Year of manufacture;
b) Type of UAS;
c) Serial number, if any;
d) Maximum payload capacity, kg; and
e) UIN (unique identification number).

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Unmanned Aerial Vehicles Sectional Committee, TED 32

Organization	*Representative(s)*
Indian Institute of Science, Bengaluru	Dr S. N. Omkar **(*Chairperson*)**
Adani Aerospace and Defence Limited, Bengaluru	Shri Sampathkumaran S. T. Shri Swapnil Jalundhwala (*Alternate*)
Aerospace and Aviation Sector Skill Council, Bengaluru	Wg Cdr Rachit Bhatnaga
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DeTect Technologies, Chennai	Shri Karthik Rajasekaran Shri G. D. Sunil (*Alternate*)
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Directorate General of Civil Aviation, New Delhi	Shri Manish Gupta Shri Praveen Kumar Singh (*Alternate*)
Drone Federation of India	Shri Smit Shah Shri Vipul Singh (*Alternate*)
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International Air Transport Association	Shri Prashant Sanglikar
International Centre for Automotive Technology, Manesar	Shri Devesh Pareek

Organization	*Representative(s)*
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International Institute of Aviation, Bengaluru	Shri Sumeet Suseelan Shrimati Smiley Sood (*Alternate*)
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Next Leap Aeronautics, Bengaluru	Shri Gajendra Kashyap
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Quality Council of India, New Delhi	Dr Manish Pande Shri C. S. Sharma (*Alternate*)
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Member Secretary
Shri Shivam Aggarwal
Scientist ‘C’/Deputy Director
(Transport Engineering), BIS

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